WHAT IS CLAIMED IS:

1. A method of producing a semiconductor device comprising:

an element adding step of adding to an amorphous silicon film a catalyst element or elements serving to promote crystallization of the amorphous silicon film, said amorphous silicon film being formed on a substrate having an insulating surface;

a first crystallization step of subjecting the amorphous silicon film to heat treatment to cause crystal growth of the amorphous silicon film, said crystal growth being stopped in a state that minute amorphous regions remain; and

a second crystallization step of irradiating the amorphous silicon film, of which the crystal growth has been stopped in a state that minute amorphous regions remain, with a strong light to cause further crystallization.

2. A method of producing a semiconductor device comprising:

an element adding step of adding to a substrate having an insulating surface a catalyst element or elements serving to promote crystallization of an amorphous silicon film;

a silicon film formation step of forming an amorphous silicon film on the substrate to which the catalyst element or elements have been added;

a first crystallization step of subjecting the amorphous silicon film to heat treatment to cause crystal growth of the amorphous silicon film, said crystal growth being stopped in a state that minute amorphous regions remain; and

a second crystallization step of irradiating the amorphous silicon film, of which the crystal growth has been stopped in a state that minute amorphous regions remain, with a strong light to cause further crystallization.

3. The method of producing a semiconductor device according to Claim 1, wherein the crystal growth in the first crystallization step is controlled by an amount of catalyst element or elements to be added to the surface of the amorphous silicon film.

4. The method of producing a semiconductor device according to Claim 3, wherein the amount of catalyst element or elements to be added to the surface of the amorphous silicon film is 1×10^{12} - 1×10^{13} atoms/cm^2 in terms of a surface concentration.

5. The method of producing a semiconductor device according to Claim 2, wherein the crystal growth in the first crystallization step is controlled by an amount of catalyst element or elements to be added to the surface of the substrate having an insulating surface.

6. The method of producing a semiconductor device according to Claim 5, wherein the amount of catalyst element or elements to be added to the surface of the substrate having an insulating surface is $1 \times 10^{12} - 1 \times 10^{13}$ atoms/cm^2 in terms of a surface concentration.

7. The method of producing a semiconductor device according to Claim 1, wherein a ratio of areas in a plane of the minute amorphous regions obtained after the first crystallization step to the whole silicon film is 10% - 50%.

8. The method of producing a semiconductor device according to Claim 7, wherein the ratio of areas in a plane of the minute amorphous regions obtained after the first crystallization step to the whole silicon film is 20% - 40%.

9. The method of producing a semiconductor device according to Claim 2, wherein a ratio of areas in a plane

of the minute amorphous regions obtained after the first crystallization step to the whole silicon film is 10% - 50%.

10. The method of producing a semiconductor device according to Claim 9, wherein the ratio of areas in a plane of the minute amorphous regions obtained after the first crystallization step to the whole silicon film is 20% - 40%.

11. The method of producing a semiconductor device according to Claim 1, wherein the silicon film obtained after the first crystallization step has the minute amorphous regions interspersed with crystallized regions thereof, and the individual amorphous regions have a planar size of 5 μm or less.

12. The method of producing a semiconductor device according to Claim 2, wherein the silicon film obtained after the first crystallization step has the minute amorphous regions interspersed with crystallized regions thereof, and the individual amorphous regions have a planar size of 5 μm or less.

13. The method of producing a semiconductor device according to Claim 1, wherein the crystallized regions of the silicon film obtained after the first crystallization

step are composed of polycrystalline silicon of which crystal grains each have a grain size of 5 μm or less.

14. The method of producing a semiconductor device according to Claim 2, wherein the crystallized regions of the silicon film obtained after the first crystallization step are composed of polycrystalline silicon of which crystal grains each have a grain size of 5 μm or less.

15. The method of producing a semiconductor device according to Claim 1, wherein said amorphous silicon film contains hydrogen and a concentration of hydrogen in this film is 3 - 25 atomic %.

16. The method of producing a semiconductor device according to Claim 15, wherein the amorphous silicon film containing hydrogen is formed by a plasma CVD method using a heating temperature of 400 °C or below.

17. The method of producing a semiconductor device according to Claim 2, wherein said amorphous silicon film contains hydrogen and a concentration of hydrogen in this film is 3 - 25 atomic %.

18. The method of producing a semiconductor device according to Claim 17, wherein the amorphous silicon film containing hydrogen is formed by a plasma CVD method using a heating temperature of 400 °C or below.

19. The method of producing a semiconductor device according to Claim 1, wherein the heat treatment in the first crystallization step is carried out at a temperature at which there occurs no spontaneous generation of crystal nuclei derived from the amorphous silicon film itself, but occurs generation of crystal nuclei derived only from the catalyst element or elements, and at which the crystal growth proceeds only with the aid of the catalyst element or elements.

20. The method of producing a semiconductor device according to Claim 19, wherein the temperature of the heat treatment in the first crystallization step is set in a range of 520°C - 570°C.

21. The method of producing a semiconductor device according to Claim 2, wherein the heat treatment in the first crystallization step is carried out at a temperature at which there occurs no spontaneous generation of crystal nuclei derived from the amorphous silicon film itself, but

occurs generation of crystal nuclei derived only from the catalyst element or elements, and at which the crystal growth proceeds only with the aid of the catalyst element or elements.

22. The method of producing a semiconductor device according to Claim 21, wherein the temperature of the heat treatment in the first crystallization step is set in a range of 520°C - 570°C.

23. The method of producing a semiconductor device according to Claim 1, wherein in the second crystallization step, the irradiation of the strong-light is performed at an intensity in a range which allows the amorphous regions to be crystallized reflecting the crystallinity of the crystallized regions, but which does not allow an original crystallinity of the crystallized regions to be lost.

24. The method of producing a semiconductor device according to Claim 23, wherein the second crystallization step comprises performing the irradiation using, as the strong light, an excimer laser light having a wavelength of 400 nm or less so that an energy density at a surface of the silicon film is 200 - 450 mJ/cm^2.

25. The method of producing a semiconductor device according to Claim 2, wherein in the second crystallization step, the irradiation of the strong-light is performed at an intensity in a range which allows the amorphous regions to be crystallized reflecting the crystallinity of the crystallized regions, but which does not allow an original crystallinity of the crystallized regions to be lost.

26. The method of producing a semiconductor device according to Claim 25, wherein the second crystallization step comprises performing the irradiation using, as the strong light, an excimer laser light having a wavelength of 400 nm or less so that an energy density at a surface of the silicon film is 200 - 450 mJ/cm^2.

27. The method of producing a semiconductor device according to Claim 1, wherein at least nickel is used as a catalyst element to promote the crystallization of the amorphous silicon film.

28. The method of producing a semiconductor device according to Claim 2, wherein at least nickel is used as a catalyst element to promote the crystallization of the amorphous silicon film.

29. The method of producing a semiconductor device according to Claim 1, further comprising, after the second crystallization step, a catalyst element-migrating step of causing most of atoms of the catalyst element or elements remaining in the silicon film to migrate to regions other than an active region of the semiconductor device.

30. The method of producing a semiconductor device according to Claim 2, further comprising, after the second crystallization step, a catalyst element-migrating step of causing most of atoms of the catalyst element or elements remaining in the silicon film to migrate to regions other than an active region of the semiconductor device.